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Software Analytics Platform for Converged Healthcare Technologies

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Abstract

The purpose of the paper is developing a common software based analytics framework that can be coupled to health devices which monitor health conditions using smart devices, mobile phones, tablets and gadgets. The diverse and heterogeneous sensor data generated can collectively be feed into local home based health information system. These information systems as a large group in cluster model form the basis of backbone networks for governmental health institutions and thereby societal impact as effect of such implementation can be studied as experimental basis of further research.

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Keywords: Smart devices, Wearable health sensors, Home networks, Health information system

1. Introduction

Healthcare systems are nowadays integral part of home networks. iCare developed by CDAC, is complete package intended to converge different healthcare and the wellness applications and provide diverse solutions including in-depth analysis of symptoms for primary care, risk prediction, interactive applications and health tips along with home remedies information. The objective is to outline a conceptual framework wherein the smart device generated data can be connected into the existing iCare modules at home base. This when extended into a larger cross section with multiple iCare modules covering certain geographical area are integrated under single server or cluster. The area servers are put under dedicated line that forms government owned Health Information System.

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2. Literature Survey

A brief and in-depth literature survey study was being done. From this was evident that in fact very few software architectures existed that integrated the device level data analytics into the health information system. This would be possible only using near field communication technologies or using wired connections. Other alternatives are Bluetooth, infrared etc. The whitepaper by Ascom discusses how the middleware integration is essential in utilizing the ubiquitous computing power in server onto devices [3].

Warren et. al in their article mentions how patient driven care and intelligent technologies are getting interoperable to access EHR and protocols being changing for standardized healthcare delivery [2]. They also developed a sample layout design setup that incorporates these elements. The iCare manual brochure had being developed using existing software requirements. [4] The only constraint factor in application was comprehensive solutions in health prediction, analysis of basic health readings and tips for better personal healthcare. The key features include Symptoms analyzer, Disease Risk predictor and healthcare based Edutainment. From this the natural evolution is analytics platform having the inbuilt medical devices data be leveraged by the computing power installed in area level health information servers. Some of these are even managed under different institutions like government hospitals, authorized government research institutions which are being given access and right to control these.

The Wello iPhone Case is particular apple company brand mobile application that can read heart rate, blood pressure, respiration, oxygen level, stress level, temperature and some more. From this the heart rate and blood pressure are critical and vital life dependent parameters that can be analyzed and predict the human health condition in immediate future. Smart devices that generate very essential signals or transducers in information of health are embedded in smart phones, gadgets, wearable devices.

3. Problem Overview

The devices that can monitor and generate health parameters data in today's scenario include smart devices like wrist bands, watches, chest strap monitors, smart phones etc. These generate essential health status information signals both in analog as well as digital format. A unique software platform built on common framework to collectively acquire, execute a basic processing task and storage into health management application is amenable. This would be installed through an information system either in home networks and government and such an implementation has key potential for further research. The objectives involve effective data management, informative inferences from software application backend.

4. Proposed Software Architecture Framework

The conceptual diagram of architecture is given in the Figure 1.High level diagram is depicted, wherein basically DB is decentralized but the health information system server database is setup in integrative model synchronized with individual clusters.

4.1 Functional Design

The Kito is an application compatible with iPhones that are Bluetooth 4.0 version number or above to interface the data being sensed. And iCare software generally runs in the Microsoft Windows environment. Now the Cluster computing is a general technique where large number of processing elements distributed in different physical locations is being combined to groups/clusters. The Cluster level information is predefined and stored into the Health information systems. For example in Figure 1 the Cluster 1 connects to 2 iCare modules from Region 1.

These can be installed in two homes which are nearby or within 50-100 meters distance. By varying individual member sizes Cluster groups (*1, 2, 3….n*) can be increased according to the requirement and setup procedure. It also depends on HIS server capacity to accommodate particular number of clients at a time.

The proposed architecture blueprint and technical framework in order to capture these parameters from smart devices with sensors processed through device software and fed into the iCare software package. At later stage this analyzed information can be maintained from iCare module into larger information system to serve group users and give accurate details as of health trends given family details and other demographic data.

iCare Health information system software further augmented would be developed to support even nanodevices in context of healthcare gadgets. In such case the Health information system needs to be upgraded to receive bigger chunks of data. The data also must be ensured to be safe and private in that scenario.

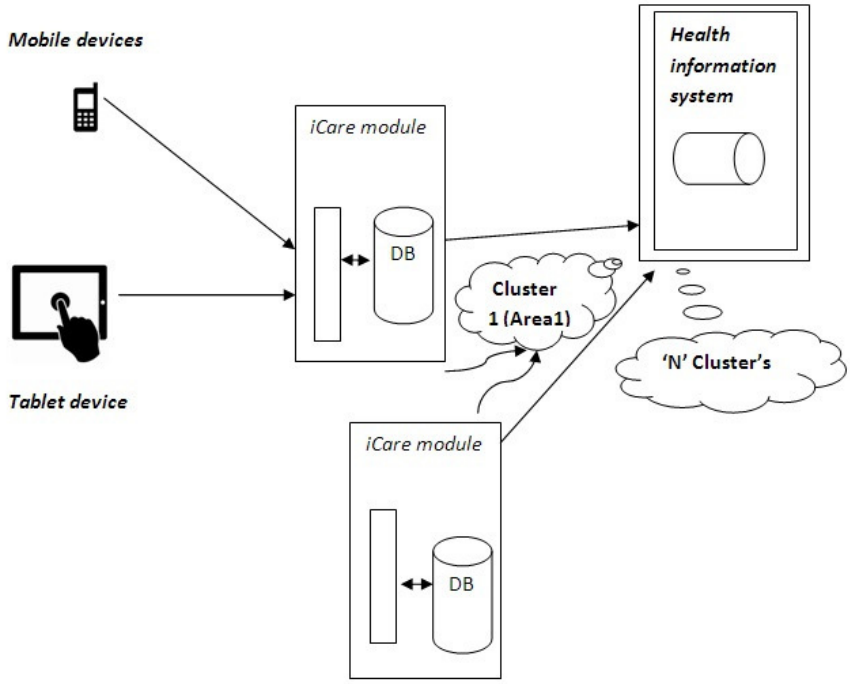

Figure 1 - Software Architecture Framework

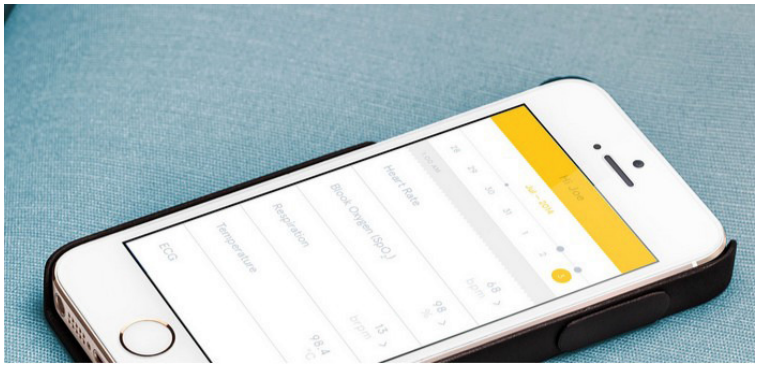

Figure 2 - Kito Mobile application

Figure 2 shows the screenshot photograph of Kito mobile application. The app primarily measures on 5 health indicators like the Heart rate, Blood oxygen, Respiration, Temperature and ECG. The advantage of adopting this technology is that any implant surgery either temporary/ permanent is avoided.

5. Data Privacy and Safety Implications

Since the connected architecture is not maintaining any database storing the confidential medical information or even critical medical data atleast in the local cluster level, there exists rare ethical problems or human privacy issues are arises. The central health information system is repository that only needs very few health parameters data such as heartbeat rate, blood pressure. etc. This is due to fact that health trend prediction is based on currently available data and not historical information. The health information system can compute the BMI values of particular family groups given their heights and weights data as in equation 1(Eq.1). The data being processed will securely be maintained or erased from system to avoid misuse or data theft. Table 1 lists the essential health parameters being monitored to make useful inferences from the iCare application that will be processed by servers in central health information system. Any permanent storage of data needs to be in compliance with appropriate regulations under Govt. of India.

6. Equations

Body Mass Index BMI can be computed with the simple formulae as given below:

$$BMI = \frac{Weight(kgs)}{Height(metres)\ x\ Height(metres)} \quad \text{(Eq. 1)}$$

7. List of Abbreviations and Tables

Abbreviations

BMI	Body Mass Index
CDAC	Centre for Development of Advanced Computing
ECG	Electrocardiogram
HIS	Health Information System
NFC	Near Field Communications

Table 1

Sl. No	Human body/ organ monitored	Health factor analyzed	Device / Instrument
1	Temperature	Body reactions	Gadget/ Mobile
2	Respiration rate	Acidotic state	Mobile
3	Pulse	Vital Body functions	Gadget/Mobile/Tablet
4	Blood pressure	Cardiac fitness	Gadget

Even with 4 numbers of most important health signals that are measured on analog or digital scale, lot of information decision inferences can be computed at Health information systems network level.

For example, increased blood pressure data above threshold value recorded over prolonged longitudinal period indicates the highly chances for cardiac issues and similar serious health effects. This rule encoded in programmatic logic of iCare predicts possible heart patients over large analyzed population sample data.

Figure 3 depicts the iCare module information window screenshot. Through such GUI interface health data can be given as input using computer, tablet or even kiosk.

Figure 3 - iCare application interface

8. Conclusions & Future Research

A pilot study involving a pre-test and post-test scenario and analysis of data reading with ANOVA/t-test or Chi-square method brings to light the effectiveness of such an approach and its implementation. Future Research directions undergone through study indicate the robust maintenance of large volumes of data being stored and simple methods to enable this information disseminated into the public with automatically generated health trend inferences [1]. Marketing information of particular medical products for use by the pharmaceutical companies based on the health trends of particular population forms a huge potential study which could be explored [2].

The barriers to healthcare access and existing technological gap in smart devices being integrated into health system forms the central research area in the Digital healthcare domain. The development of smart clothing and nano-technology backed healthcare technologies poses even greater challenges in interoperability and seamless connectivity for cohesive nature of technology based information decision systems.

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